Study of Collocated Sources of Air Pollution and the Potential For Circumventing Regulatory Major Source Permitting Requirements near Sun City, Arizona

by

Timothy S. Franquist, Jr.

A Thesis Presented in Partial Fulfillment
of the Requirements for the Degree
Master of Science in Technology

Approved November 2011 by the
Graduate Supervisory Committee:

Larry Olson, Chair
Albert Brown
Nicholas Hild

ARIZONA STATE UNIVERSITY

December 2011

ABSTRACT

The following research is a regulatory and emissions analysis of collocated sources of air pollution as they relate to the definition of "major, stationary, sources", if their emissions were amalgamated. The emitting sources chosen for this study are seven facilities located in a single, aggregate mining pit, along the Aqua Fria riverbed in Sun City, Arizona. The sources in question consist of Rock Crushing and Screening plants, Hot Mix Asphalt plants, and Concrete Batch plants. Generally, individual facilities with emissions of a criteria air pollutant over 100 tons per year or 70 tons per year for PM_{10} in the Maricopa County non-attainment area would be required to operate under a different permitting regime than those with emissions less than stated above. In addition, facility's that emit over 25 tons per year or 150 pounds per hour of NOx would trigger Maricopa County Best Available Control Technology (BACT) and would be required to install more stringent pollution controls. However, in order to circumvent the more stringent permitting requirements, some facilities have "collocated" in order to escape having their emissions calculated as single source, while operating as a single, production entity. The results of this study indicate that the sources analyzed do not collectively emit major source levels of emissions; however, they do trigger year and daily BACT for NO_x. It was also discovered that lack of grid power contributes to the use of generators, which is the main source of emissions. Therefore, if grid electricity was introduced in outlying areas of Maricopa County, facilities could significantly reduce the use of generator power; thereby, reducing pollutants associated with generator use.

ACKNOWLEDGMENTS

I wish to express my sincere appreciation to the following people:

Dr. Larry Olson, for agreeing to chair my committee and for his valued assistance throughout the thesis process.

Dr. Nicolas Hild, for his assistance and guidance throughout the thesis research process and Masters program.

Mr. Brown, for agreeing to serve on my committee and for his guidance throughout the thesis process.

TABLE OF CONTENTS

CHAPTER Page

LIST OF TABLES

LIST OF FIGURES

DEFINITION OF TERMS AND ACRONYMS

TERM/ACRONYM	DEFINITION
A.A.C.	Arizona Administrative Code
AEI	Annual Emissions Inventory
Best Available Control Technology	The most stringent limitation or control technique that is technology feasible, cost-effective and has been achieved in practice for such emissions unit and class source. (MCAQD Rule 241, Section 300)
Categorical Source	According to the ACC R18-2-401.2, means the following classes of sources: a. Coal cleaning plants with thermal dryers; b. Kraft pulp mills; c. Portland cement plants; d. Primary zinc smelters; e. Iron and steel mills; f. Primary aluminum ore reduction plants; g. Primary copper smelters; h. Municipal incinerators capable of charging more than 50 tons of refuse per day; i. Hydrofluoric, sulfuric, or nitric acid plants; j. Petroleum refineries; k. Lime plants; l. Phosphate rock processing plants; m. Coke oven batteries; n. Sulfur recovery plants; o. Carbon black plants using the furnace process; p. Primary lead smelters; q. Fuel conversion plants; r. Sintering plants; s. Secondary metal production plants; t. Chemical process plants; u. Fossil-fuel boilers, combinations thereof, totaling more than 250 million Btu's per hour heat input; v. Petroleum storage and transfer units with a total storage capacity more than 300,000 barrels; w. Taconite preprocessing plants; x. Glass fiber processing plants; y. Charcoal production plants;

z. Fossil-fuel-fired steam electric plants and combined cycle gas turbines of more than 250 million Btu's per hour heat input

Criteria Pollutant — Ozone, nitrous oxides, sulfur dioxide, carbon monoxide, lead, particulate matter ($PM_{2.5}$ and PM_{10}). (Clean Air Act, 1970 as amended)

Collocation — Highly concentrated amalgamation of industrial facilities emitting air pollution

Major Source — According to the ACC Title 18, Chapter 2, Article 4, means:

a. Any stationary source located in a nonattainment area that emits, or has the potential to emit, 100 tons per year or more of any conventional air pollutant, except as follows:

Pollutant Emitted	Nonattainment Pollutant and Classification	Quantity Threshold tons/year or more
Carbon Monoxide (CO)	CO, Serious, with stationary sources as more than 25% of source inventory	50
Volatile Organic Compounds (VOC)	Ozone, Serious	50
VOC	Ozone, Severe	25
PM 10	PM 10 , Serious	70
NOx	Ozone, Serious	50
NOx	Ozone, Severe	25

b. Any stationary source located in an attainment or unclassifiable area that emits, or has the potential to emit, 100 tons per year or more of any conventional air pollutant if the source is classified as a Categorical Source, or 250 tons per year or more of any pollutant subject to regulation under the Act if the source is not classified as a Categorical Source;

	c. Any change to a minor source, except for VOC or NOx emission increases at minor sources in serious or severe ozone nonattainment areas, that would increase its emissions to the qualifying levels in subsections (a) or (b); d. in VOC or NOx at a minor source in serious or severe ozone nonattainment areas that would be "significant" under R18-2-405(B) and that would increase its emissions to the qualifying levels in subsection (a); e. Any stationary source that emits, or has the potential to emit, five or more tons of lead per year; f. Any source classified as major undergoing modification that meets the definition of reconstruction; g. A major source that is major for VOC shall be considered major for ozone; or h. A major source that is major for oxides of nitrogen shall be major for ozone in nonattainment areas classified as marginal, moderate, serious, or severe
Non-Attainment	An area, based on monitored data, that is not meeting the National Ambient Air Quality Standard for a particular criteria air pollutant
Nitrogen oxides (NO_x)	Is a group of highly reactive gasses known as oxides of nitrogen or nitrogen oxides (NOx). Other nitrogen oxides include nitrogen dioxide, nitrous acid, and nitric acid.
Particulate Matter	The USEPA groups particle pollution into two categories: • Inhalable coarse particles, such as those found near roadways and dusty industries, are larger than 2.5 micrometers and smaller than 10 micrometers in diameter. • Fine particles, such as those found in smoke and haze, are 2.5 micrometers in diameter and smaller. These particles can be directly emitted from sources such as forest fires, or they can form when gases emitted from power plants, industries and automobiles react in the air.

Potential-to-Emit	Potential to emit means the maximum capacity of a stationary source to emit a pollutant, excluding secondary emissions, under its physical and operational design. Any physical or operational limitation on the capacity of the source to emit a pollutant, including air pollution control equipment and restrictions on hours of operation or on the type or amount of material combusted, stored, or processed, shall be treated as part of its design if the limitation or the effect it would have on emissions is federally enforceable. (A.A.C R18-2-101.91)
Stationary Source	According to AAC R18-2-101.113, means any building, structure, facility or installation subject to regulation pursuant to A.R.S. § 49-426(A) which emits or may emit any air pollutant. "Building," "structure," "facility," or "installation" means all of the pollutant-emitting activities which belong to the same industrial grouping, are located on one or more contiguous or adjacent properties, and are under the control of the same person or persons under common control. Pollutant-emitting activities shall be considered as part of the same industrial grouping if they belong to the same "Major Group" as described in the "Standard Industrial Classification Manual, 1987". (Note: SIC criteria in terms of Stationary Source will be discussed in further detail in Chapter 1)
Volatile Organic Compounds	Hydrocarbon compounds that have low boiling points, usually less than 100ºC, and therefore evaporate readily. Some are gases at room temperature. Propane, benzene, and other components of gasoline are all volatile organic compounds.

Chapter 1

INTRODUCTION

The State of Arizona is a leader in aggregate resources and was ranked 8th in the nation for aggregate production in 2008 (Willett, 2010). However, with an increasing and expanding population in the Phoenix Metropolitan area, more people are potentially exposed to the particulate matter and gaseous emissions from rock product facilities located at urban aggregate mining sites.

The Arizona Department of Environmental Quality (ADEQ), along with Pima County, Pinal County, and Maricopa County have observed that rock products facilities, i.e. Hot Mix Asphalt Plants (HMAP), Concrete Batch Plants (CBP), and Crushing/Screening Plants (C&S) have been “collocating” or concentrating in specific areas. In a majority of instances, the collocation of facilities is a function of the raw materials available in a given aggregate mining pit. However, there can also be a negative public health effect caused by facilities that collocate for the purpose of circumventing being categorized as a major stationary source pursuant to 42 USC § 7401 (“the Clean Air Act”) and A.A.C R18-2-401.

Collocated facilities may have the potential to emit major source levels of air pollution depending on the size and concentration of the facilities involved. Moreover, if the collocated facilities are supporting the same project, they could be evading the requirement to obtain more stringent permits, i.e. Arizona Class I, Title V, Prevention of Significant Deterioration (PSD) or Non-Attainment New Source Review (NNSR) permits. As a result of collocation, public health may be negatively impacted due to the subsequent circumvention of more stringent pollution controls required by the above permitting regimes.

The benefit to collocated facilities to circumvent major source permits is that Arizona Class I, Title V, or PSD/NSR permits are significantly more expensive for the facility to obtain and would ultimately require higher costs associated with pollution controls, monitoring, and recordkeeping. As a result, collocated facilities are *potentially* incurring a cost benefit by circumventing Arizona Class I, Federal PSD/NNSR, Federal Title V permit requirements, or triggering Maricopa County Best Available Control Technology (BACT), while exposing the public to elevated levels of air pollution.

Major, Stationary Source and Maricopa County BACT

To be required to obtain an Arizona Class I, Federal Title V, or PSD/NNSR permit, a facility must meet the criteria of major, stationary source and emit 100 tons per year of a criteria pollutant for Title V purposes or emit 100 tons per year (tpy) of a criteria pollutant for “categorical sources” or 250 tpy for non-categorical sources for PSD and NNSR. The 26 categorical sources consist of industries that have similar processes and equipment with well-defined emission outputs among each industrial category. It is important to note that the facilities used in this this study are not categorical sources.

In order for the collocated facilities to be considered a single stationary source, they must meet the definition of a stationary source pursuant to A.A.C. R18-2-101.113, which states, “any building, structure, facility or installation subject to regulation pursuant to A.R.S. § 49-426(A) which emits or may emit any air pollutant. “Building,” “structure,” “facility,” or “installation” means all of the pollutant-emitting activities which belong to the same industrial grouping, are located on one or more contiguous or adjacent properties, and are under the control of the same person or persons under common control. Pollutant-emitting activities shall be considered as part of the same industrial grouping if they belong to the same “Major Group” as described in the “Standard Industrial Classification Manual, 1987.”

A facility must meet all three criteria to be defined as a stationary source. For the first criteria, i.e. Standard Industrial Classification (SIC), a facility would register their activities within the corresponding SIC category. However, as SICs relates to the stationary source definition, the facilities in question might not be categorized in the same Standard Industrial Classification (SIC). However, the collocated facilities often fit the definition of a support facility designation and therefore, meet the SIC criteria as indicated in the August 7, 1980 preamble to the PSD regulations (45 FR 52695). The USEPA’s criteria for a “support facility” is as follows:

> “[e]ach source is to be classified according to its primary activity, which is determined by its principal product or group of products produced or distributed, or services rendered. Thus, one source classification encompasses both primary and support facilities, even when the latter includes units with a different two-digit SIC code (emphasis added). Support facilities are typically those which convey, store, or otherwise assist in the production of the principal

product. Where a single unit is used to support two otherwise distint sets of activities, the unit is to be included within the source which relies most heavily on its support."

The purpose of using the Support Facility Designation in making a SIC determination is to prevent multiple facilities involved in same commercial output from breaking themselves into compartmentalized activities for the purpose of circumventing the stationary source criteria. For example, the types of industries involved in road construction require the use of Crushing & Screening operations and Hot Mix Asphalt production. In order to make Hot Mix Asphalt, a ready supply of crushed rock must be available. Typically, both the HMAP and C&S plant would be located next to each other or as close as possible so to reduce material transport costs. However, both facilities are impacting the same airshed while supporting the same project. Therefore, if the same project were comprised of these sub-operational units, those operations would be categorized as "support facilities".

The support facility designation in turn leads into the next stationary source criteria, that is, adjacent or contiguous property. Since the facilities supporting each other are normally located close to the economic market being supplied, the question of geographic location becomes an issue, again, due to the impact to the same airshed. Normally, this determination is a simple geographical assessment as the physical proximity to the facilities in question is just a matter of distance and location. However, depending on the activity, conveyances (e.g.

belts, pipes, etc.), dedicated railroads, and other types of dedicated infrastructure could be used to link support facilities to each other.

Finally, the element of common control must be determined. The Arizona Administrative Code is silent in defining what constitutes common control. In these situations, where no clear regulatory definition is available, regulators and facilities are left to make discretionary determinations of common control. On face value, one can assume that companies fully operated under the same management or corporate structure generally are under common control. Yet, under the circumstances of collocation, the facilities are usually completely different corporate entities (as are the facilities used in this research). In determining common control in situations where the facilities are separately owned but are support facilities in that they are producing products for the same project, it is the subcontractor bids, invoices, material contracts, dedicated material contracts etc., that substitute for same management or corporate structural control. However, using bids, invoices, and contract directives can be problematic in determining common control as corporate structural linkages are difficult to obtain, as those documents usually contain business confidential information such as profit information, whole sale raw stock purchase prices, etc.

Another crucial regulatory emissions analysis in regards to Maricopa County is the county's emissions threshold for installing pollution controls that meet Best Available Control Technology (BACT). Maricopa County Rule 241, Section 300 requires BACT for any new stationary source or modified source, which emits more than 150 lbs/day or 25 tons/year of volatile organic compounds, nitrogen oxides, sulfur dioxide, or particulate matter; more than 85 lbs/day or 15 tons/year of PM_{10}; or more than 550 lbs/day or 100 tons/year of carbon monoxide. According to Maricopa County, BACT is defined as, "the most stringent limitation or control technique that is technologically feasible, cost-effective and has been achieved in practice for such emissions unit and class of source. The control equipment or technology must be commercially available, and have been demonstrated to be effective and reliable on a full scale unit and shown to be cost-effective on a dollars-per-ton of pollutant removed basis. The term "achieved in practice" applies to the most effective emission control device already in use, or the most stringent emission limit achieved in the field for the type and capacity of equipment comprising the source under review and operating under similar conditions." (MCAQD, 2008) Therefore, facilities operating in Maricopa County are also required to meet the local emission related regulations, along with State and Federal requirements.

Statement of the Problem

There are potential health issues, which are in part rooted in the current permitting mechanisms available to the rock products industries in Arizona. The issue arises based on the regulatory criteria for a facility being categorized as a "major, stationary source", e.g. common ownership or control, adjacent or contiguous property, and the same Standardized Industrial Classification (SIC) or support facility designation. Facilities that are categorized as major stationary sources are required by State and Federal regulations to increase pollution control measures, monitoring, recording, and recording-keeping activities. However, if facilities can break themselves into operational subsets, they may escape being categorized as a major source and circumvent more stringent permits and air pollution controls.

Under the current permitting regime, if facilities collocate (or cluster) and escape being categorized as a “major source”, then less pollution is attributed to the individual facilities when determining their initial Potential-to-Emit. However, in reality several facilities in one location may be supporting each other’s operations or supporting the same project and in that case, the collection of facilities would constitute a single major, stationary source. The ultimate effect of collocation is that one would anecdotally expect that increased exposure to air pollution would have adverse health effects on the populations adjacent to collocated sources.

More specifically, this research explored collocated sources’ actual emissions and summed the emissions of seven sources operating in a single aggregate mining site located near Sun City, Arizona. An amalgamated emissions calculation and a regulatory analysis was undertaken to determine whether or not the collocated sources constitute a “major source”. If the collocated sources are determined to be a major source and are operating under a less stringent permit regime from a pollution control perspective than that required by the Title V or NSR/PSD source, then one would expect adverse public health effects by increasing the public’s exposure to the pollutants produced by collocated sources.

Annual emissions data will be used to make a major source determination as opposed to Potential-to-Emit. Annual emissions data was used to assess the actual emissions be emitting from the facilities in the study area. Since all enforceable pollution controls, hours of operation restrictions, etc. have been previously negotiated, albeit, on an individual facility basis, the AEI will represent a more accurate assessment of the emissions impact from the collocated facilities studied in this research.

Objective

This study focused on emissions of particulate matter of ten microns or less (PM_{10}), nitrogen oxides (NO_x), ozone, and sulfur oxides (SO_x) from collocated sources in an aggregate mining pit located along the Aqua Fria river bed in the Maricopa County PM_{10} Serious Nonattainment Area (Figure 1 – Map of Sources in Subject Area). The Aqua Fria riverbed is an area known for collocated sources of rock product facilities as was discovered by a 2008 permitted source mapping project conducted by ADEQ (Figure 1).

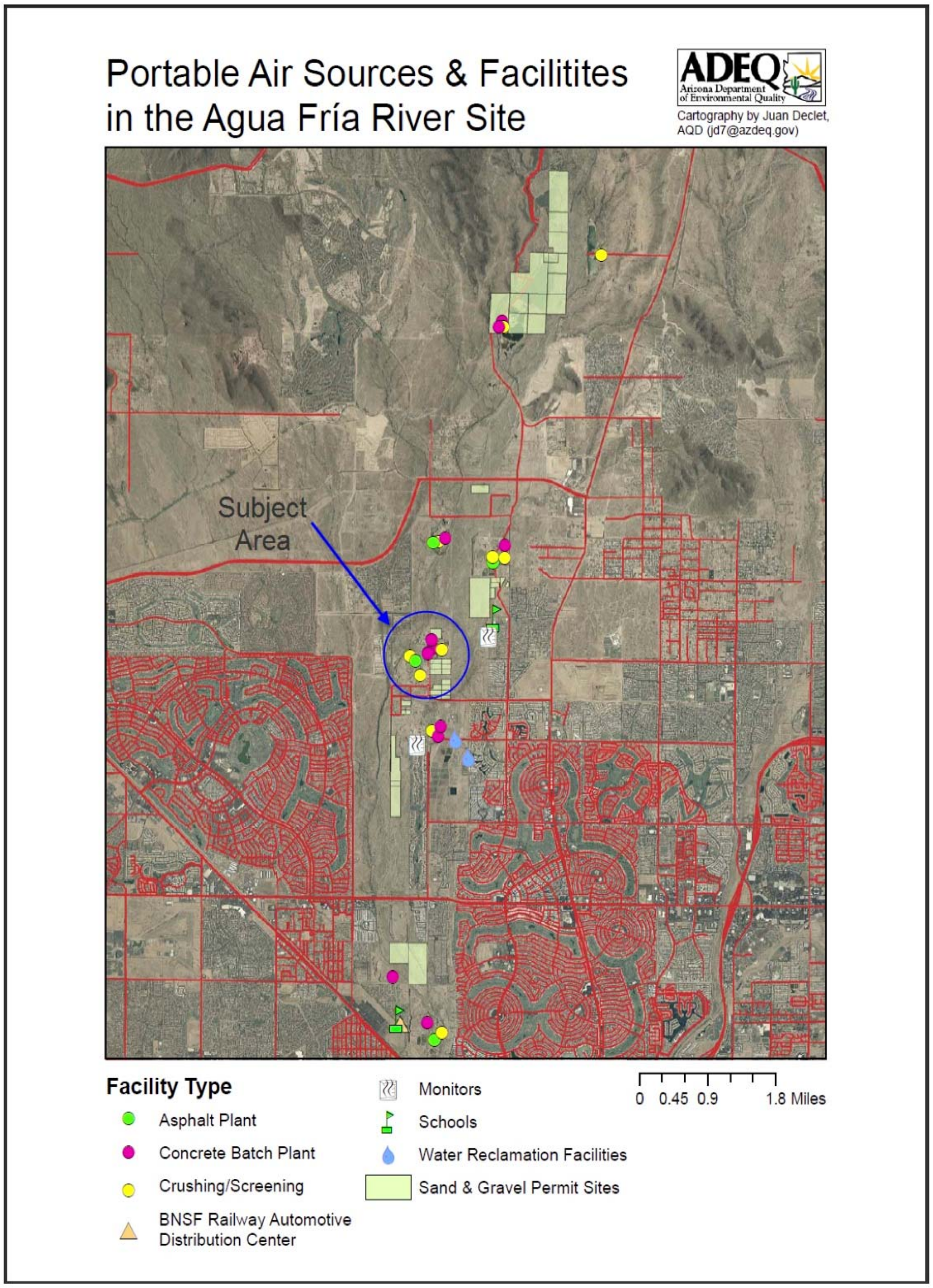
The objectives of this regulatory and emissions analysis is to:

- Analyze the collective emissions impact of collocated sources by aggregating their emissions as a single facility.
- To determine if the collective emissions from the collocated sources constitute a major source.
- To determine if the facilities in the study area collectively trigger Maricopa County Best Available Control Technology.
- To analyze each facility's emissions profile by process or equipment to determine which processes have the highest

emissions and therefore have the highest potential to negatively impact public health and the environment.

The presumption is that increased pollution in the study area could contribute to negative health effects to the nearby residents. The negative health affects of PM_{10}, NO_x, SO_x, and ozone will be discussed in more detail in Chapter 2.

Figure 1 – Portable Air Sources & Facilities in the Agua Fria River Site



Source: ADEQ 2008

Scope

This research relied on the Annual Emissions Inventory (AEI) submitted to ADEQ and the Maricopa County Air Quality Department by several facilities located within the Aqua Fria river bed study area. The AEI used for this study were the official documents submitted by the facilities; however, the names of the facilities involved in the research were redacted. The AEI were requested from the respective regulatory agencies and represent the official emissions output from the facility. The AEIs were used in this study as opposed to the Potential-to-Emit (PTE) calculations to access the actual or real world emissions output in order to determine the emissions the public is being exposed to. However, a permitting agency would use an uncontrolled PTE from a pre-permitting determination to access the emissions from all the facilities in the study area to make a permitting determination (i.e. what permit would be required given the level of emissions). According to the definition of PTE, operational designs limiting emissions and any enforceable hours of operation restrictions and/or pollution controls would also be used to calculate a revised or controlled PTE, which is the emission output that would be used to permit a given facility. The reason AEIs were selected over the PTE is that PTE would be collectively negotiated in terms of voluntary accepted limitations on hours of operation, pollution controls, and other work practice or technological controls to decrease the companies' collective PTE. Conversely, the AEI represents the actual emissions given the above emission limitations, albeit, negotiated on facility-by-facility basis and not as single source. The AEI represents the emissions from all the collocated facilities and not the potential emissions if the companies operated 24-hours a day, seven days a week without controls.

Lastly, in terms of temporal and spatial scope, this research will be focused on emissions from Calendar 2007 associated with collocated sources located in the Aqua Fria river bed near Sun City. ADEQ performed a 2008 internal regulatory survey of the Aqua Fria riverbed, which included the study area. The map was requested from ADEQ for use in this thesis (Figure 1). The emissions data used in this research were limited to 2007 and only represent a distinct geographical area in the Aqua Fria riverbed (Note: 2007 emissions data is submitted in the calendar year 2008 and represents the previous year's emissions).

Target Area. The study area was an open pit, aggregate mining site located in the Aqua Fria riverbed with a concentration of collocated sources. ADEQ's Air Quality Division produced a GIS map of the area based on an ADEQ survey of permitted sources along the riverbed, which was conducted in 2008 (ADEQ, 2008). The facilities used in this study are listed below, along with their emissions per unit or source. The collective emissions tables are presented in Chapter 4.

Facilities Operating in Aqua Fria Riverbed Aggregate Pit (Near Sun City)

Company A

- Concrete Batch Plant
- Operating under a General Permit for Concrete Batch Plants issued by ADEQ, Air Quality Division.

Emission Source	NO_x (tpy)	PM_{10} (tpy)	SO_x (tpy)	CO (tpy)	VOC (tpy)
Drop Points, Material Transfer and Loading	0	0.0018	0	0	0
Storage Piles	0	0.0006	0	0	0
Haul Roads	0	0.0084	0	0	0
Generator (s)	0.01	0.0007	0.006	0.40	0.02

(Gasoline)					
Total	0.01	0.012	0.006	0.40	0.02

Company B

- Concrete Batch Plant
- Operating under a General Permit for Concrete Batch Plants issued by the Maricopa County Air Quality Department.

Emission Source	NO_x (tpy)	PM_{10} (tpy)	SO_x (tpy)	CO (tpy)	VOC (tpy)
Drop Points, Material Transfer and Loading	No Data	0.51	No Data	No Data	No Data
Storage Piles	No Data	0.114	No Data	No Data	No Data
Haul Roads	No Data	3.23	No Data	No Data	No Data
Generator (s)	No Data	N/A	No Data	No Data	No Data
Total	No Data	3.85	No Data	No Data	No Data

Company C

- Crushing and Screening Plant
- Operating under a General Permit for Crushing and Screening issued by the Maricopa County Air Quality Department.
- No emissions data available

Company D

- Concrete Batch Plant
- Operating under a General Permit for Concrete Batch Plants issued by the Maricopa County Air Quality Department.

Emission Source	NO_x (tpy)	PM_{10} (tpy)	SO_x (tpy)	CO (tpy)	VOC (tpy)
Drop Points, Material Transfer and Loading	0	0.28	0	0	0
Storage Piles	0	0.095	0	0	0
Haul Roads	0	0.39	0	0	0
Propane Heater	0.32	0.0009	0.00025	0.0043	0.0012
Total	0.32	0.77	0.00025	0.0043	0.0012

Company E

- Crushing and Screening Plant
- Operating under a General Permit for Crushing and Screening issued by ADEQ, Air Quality Division.

Emission Source	NO_x (tpy)	PM_{10} (tpy)	SO_x (tpy)	CO (tpy)	VOC (tpy)
Loading, Secondary Crushing, Screening, Material Transfer	0	0.039	0	0	0
Haul Roads	0	0.84	0	0	0

Storage Piles	0	0.0027	0	0	0
Generator (s)	19.5	0.55	5.49	4.45	0.66
Total	19.5	1.43	5.49	4.45	0.66

Company F

- Hot Mix Asphalt Plant
- Operating under a General Permit for Hot Mix Asphalt Plants issued by ADEQ, Air Quality Division.

Emission Source	NO_x (tpy)	PM_{10} (tpy)	SO_x (tpy)	CO (tpy)	VOC (tpy)
Asphalt Cement Storage (Heaters)	0.24	0.088	0.23	0.49	0.12
Haul Roads	0	0.006	0	0	0
Storage Piles	0	0	0	0	0
Generator (s)	0.84	0.02	0.25	0.20	0.02
Drop Points, Material Transfer, Screening	0.89	0.21	0	0	0.02
Total	1.97	0.32	0.48	0.69	0.16

Company G

- Crushing and Screen Plant
- Operating under a General Permit for Crushing and Screening issued by ADEQ, Air Quality Division.

Emission Source	NO_x (tpy)	PM_{10} (tpy)	SO_x (tpy)	CO (tpy)	VOC (tpy)
Loading, Secondary Crushing, Screening, Material Transfer	0	1.5	0	0	0
Haul Roads	0	0.63	0	0	0
Storage Piles	0	0.0002	0	0	0
Generator (s)	30.26	0.72	9.18	6.93	0.89
Total	30.26	2.85	9.18	6.93	0.89

Assumptions. This study assumes that the facilities were located at the Agua Fria riverbed study area for a full year and the equipment used at the site remained the same or substantively similar throughout the year. In many cases, portable facilities are used in the extraction of the aggregate resource; however, if equipment is changed at a mining site, it is usually replaced with the same or similar equipment; otherwise, a permit revision or a new Authorization to Operate is required from either ADEQ or Maricopa County. No substantive permit revisions or revised Authorizations to Operation appear to be associated with any of the facilities reviewed. Additionally, it is assumed that the facilities operated only five-days per week.

The AEI will be the source of data used for this study. The AEI represents the formal emissions output for a facility, as they are the calculations submitted to the respective regulatory agencies. It is assumed that since the AEIs used in this study were the official documents submitted by the respective facilities, reviewed by the appropriate regulatory agencies, and filed in the official public files, that the calculations used for the AEIs are valid and reliable. This study did not re-review the underlying variables used in the AEIs and this research is relying on the regulatory review by ADEQ and MCAQD of the AEI data submitted by the facilities identified above.

This research assumed that increased pollution generally has a negative impact on public health. In addition, it is also assumed that the closer a population is to a source of air pollution then the population is being exposed to an increased concentration to pollution. In other words, there is an inverse relationship between distance to a pollution source and exposure to pollution; therefore, as distance decreases, pollution exposure increases.

<u>Limitations.</u> This study is geographically limited to an aggregate mining pit located in the Aqua Fria riverbed and is a limited regulatory assessment of the emissions as they relate to “major source” definitions. This research will not make a determination of common ownership or control as the documents required to access common control are deemed business confidential. The documents needed

to make a common control determination include, but are not limited to, accepted bids to provide support for the same project, invoices, contractual directives, and dedicated material supply contracts.

This research does not model any emission impacts to the surrounding airsheds or attempt to make any air quality impact statements in regards to attaining or violating any of the National Ambient Air Quality Standards. This research is strictly limited to emissions as they relate to regulatory definitions that ultimately dictate the type of permit and pollution controls that may be required for triggering specific regulatory emission thresholds.

Summary

In summary, this research will analyze aggregated emissions for several facilities in a mining site along the Aqua Fria river bed using the AEI data submitted to ADEQ and MCAQD. Chapter 2 provides a review of literature regarding the health effects of PM_{10}, NO_x and Ozone, Ambient Air Quality Studies of Gaseous and Particulate Matter, and research on industrial collocation in regards to emissions, regulatory definition of “major source” and briefly “stationary sources” (including stationary source sub-components, i.e. contiguous or adjacent properties, common control, and same Standard Industrial Code or support facility designation).

Chapter 2

LITERATURE REVIEW

Health Effects of PM_{10}, NO_X and Ozone

The term “air pollution” refers to a complex universe of chemicals emitted to the atmosphere that directly or indirectly degrades public health and welfare. Air pollution has been anecdotally defined as, “chemical compounds that are in the wrong place or in the wrong concentrations at the wrong time.” (Bryner, 1993) Adding to the difficulty of identifying the health effects of air pollution is that every human population has different sensitivities to different air pollutants and a majority of the studies on air pollutants do not address the synergistic or interactive effects (Bryner, 1993).

Particulate Matter

Of serious concern to public health in the Phoenix Metropolitan area and Maricopa County is particulate matter of ten microns or less (PM_{10}). Some scientists consider PM_{10} to pose a greater health risk than many other forms of air pollution due to the varied chemical composition of PM_{10}, which can range from dirt particles to heavy metals. The chemical composition of PM_{10} can also contain compounds associated with dirt/clay (i.e. hydroxyl compounds), mercury, sulfur, arsenic, asbestos, or even radioactive compounds (Byner, 1993).

PM_{10} can be emitted from a myriad of different natural and industrial sources, including coal fired power plants, disturbed open areas, portable electrical generators, or agricultural lands. PM_{10} from agricultural sources such as Concentrated Animal Feeding Operations (CAFO) or manure storage areas can very likely contain pathogens that cause disease as the particulate matter is composed of dried animal waste (Ebner, 2007).

PM_{10} and smaller particles are considered a more serious health risk than larger particles since finer particles are not filtered out of the body by the nasal-pharynx region prior to entering the lungs (Bryner, 1993). PM_{10} can cause eye and throat irritation, bronchitis, lung damage, impaired visibility, and in some cases, cancer (Bryner, 1993). The United States Environmental Protection Agency (USEPA) states that PM_{10} can aggravate asthma symptoms, cause irregular heartbeats, which may lead to heart attacks (USEPA, 2010). PM_{10} has also been linked with the formation of hydroxyl free radical activity in the body and have been shown to degrade DNA (Gilmour, 1996).

Nitrogen Oxides and Ozone

Unlike PM_{10}, nitrogen oxides (NO_x) and ozone (O_3) are "single, well-defined" air pollutants. Seven oxides of nitrogen are known to occur in the atmosphere and NO_x is the symbol for the sum of nitric oxide (NO) and nitrogen dioxide (NO_2) (USEPA, 1997). NO_x is formed from the combustion of fossil fuels such as vehicles, heavy equipment (e.g. loaders, bulldozers, etc), hot mix asphalt production, and portable electric generators, all of which were used in the Aqua Fria study area (See Chapter 1 for emissions profile by facility). Mobile sources or vehicles are a major contributor to NO_x emissions, but coal-fired power plants, portable electrical generators, and agricultural fields treated with nitrate rich fertilizers are also major contributors to NO_x production (USEPA, 1997).

Ozone is a secondary pollutant and is formed by the emissions of Volatile Organic Compounds and NO_x compounds. In short, ozone is formed by the liberation of an oxygen atom from a NO_x compounds and VOC containing oxygen atoms by photochemical reactions (Ebbing, 1993). Therefore, increases in NO_x and VOCs in sunny environments increase ozone formation. The smog observed in Los Angeles and Mexico City are examples of photochemical smog indicative of high NO_x emissions and subsequent ozone formation (Sillman, 2010).

The health effects of NO_x include, changes in airway responsiveness, pulmonary function in individuals with pre-existing respiratory illnesses, and increases in respiratory illnesses (USEPA, 1997). Nitrogen oxide can also be an asphyxiant at high concentrations (Hathaway et al, 1991). At low concentrations, nitrogen oxides can cause central nervous system impairment, cardiovascular, hepatic, hematopoietic, and reproductive effects in humans (Hathaway et al, 1991). It is reported that prolonged exposure to a 50:50 nitrous oxide/oxygen mixture when being used to induce anesthesia in humans can induce continuous sedation and could cause bone marrow depression and granulocytopenia (Hathaway et al, 1991). Even more alarming is that neurotoxic effects can occur after acute exposure to concentrations of 80,000 to 200,000 ppm and above with health effects including, decreased reaction times and performance, which could lead to occupational and/or domestic related mechanical injuries (Hathaway et al, 1991). Long-term occupational exposure has been associated with numbness, difficulty in concentrating, paresthesias, and impairment of equilibrium (Hathaway et al, 1991).

According to the Markus Amann of the World Health Organization, "There are large multi-city studies relating the numbers of hospital admissions for respiratory diseases and [Chronic obstructive pulmonary disease] to ambient ozone levels" (Amann, 2008). Ozone appears to affect the elderly by increasing mortality rates associated strokes or by aggravating symptoms of pre-existing respiratory disease (Amann, 2008). Ozone can cause lung and eye irritation, labored breathing, and sore throats (Sillman, 2010). Studies show that increased exposure to ozone increases the likelihood of labored breathing (wheezing and chest tightness), asthma, and reduced expiratory flow rates in children with lower birth weights or those born prematurely (Amann, 2008).

The other major effects of NO_x and ozone are its negative effects on human welfare, which include crop destruction, contribution to acid rain, increased pH in surface water systems, contribution of nitrate contamination of ground water, and inhibiting the growth of plants and forests (Blankenship, 1997).

Ambient Air Quality Studies of Gaseous and PM_{10} Emissions

The Clean Air Act (CAA) was developed for the purpose of protecting the public's ambient air quality. The necessity to develop comprehensive air quality laws and regulations was due to numerous historical instances where the ambient air directly affected public health or even caused fatalities. A well know ambient air quality event occurred in Donora, Pennsylvania on October 26, 1948, which caused illness in approximately 5,000 to 7,000 residents and killed 20 people

(Helfand, 2001). The CAA was subsequently revised and “strengthened” in 1963, 1970, and 1990 and is considered in large part to be responsible for better air quality and public health (Helfand, 2001).

Discussed below are ambient air quality studies, both of which appear to support the generalization that the ambient air is getting cleaner, at least on a macro airshed level; however, the studies also indicate that populations closer to concentrated industry are negatively impacted by air pollutants.

The first study investigated the correlation of cancer instances associated with ambient air quality in a suburb of Rome, Italy. The Town of Malagrotta is in close proximity to a large waste disposal site, incinerator, and a refinery. The air pollution emitted from these three sources are significant in terms of quantity and health effects (Michelozzi, 1998). In regards to the pollutants of concern in this thesis, namely PM_{10}, NOx, and Ozone, the pollutants from the Malagrotta sources are significantly more concerning from a public health standpoint due to the toxicity of the emissions. The chemicals emitted from the Malagrotta sources include, particulates, hydrogen chloride, chlorinated dibenzo-p-dioxins dibenzofurans, polycyclic aromatic, hydrocarbons, (PAHs), chlorinated benzene, chlorinated phenols, and phthalates (Michelozzi, 1998).

The Malagrotta study indicates no statistical association between the proximity of the industrial sources of emissions and increased cancer rates for the categories studied; however, the study did indentify a trend of decreasing instances of laryngeal cancer as the distance from incinerators increased (Michelozzi, 1998). Therefore, an inverse relationship of distance to exposure was identified and was significant enough to warrant further investigation. The study in effect identified a potential public health issue with populations located near concentrated (or collocated) sources of air pollution. Similar to the Aqua Fria riverbed sources, the increased concentration of industrial sources could be expected to affect ambient air quality and public health on a micro airshed level.

A study conducted by S. Larssen and the Environmental Pollution Research Institute (EPRI) investigated several suburbs of Mumbai, India. The purpose of the study was to determine the affect of pollution (particularly NO_x) caused by vehicles on the adjacent communities and if the same populations located near large fertilizer factories experienced higher instances of respiratory illness (Larssen, 1997). The first study began in 1978 and showed higher cases of respiratory illness in the suburb of Parel compared to Chembur, but linked vehicle traffic to the differences in health issues (Larssen, 1997). However, follow-up studies conducted from 1988 through 1990 in both suburbs found different trends. The study revealed that higher instances of respiratory and other breathing related illness had shifted toward the communities closer to the fertilizer factor as lead and other pollutants found in vehicle fuels changed in concentration or were phased out over the years (Larssen, 1997). Therefore, the study showed that incidence of symptoms declined as distance from the chemical factories increased.

For example, the EPRI study showed that 80 percent of the sample reported symptoms such as headache and eye irritation in the Maharashtra State Electricity Board (MSEB) colony located approximately 100 meters from the

Oswal Agro chemical factory; 73 percent reported similar symptoms in the Railway Colony located approximately 500 meters from the Rashtriya Chemicals and Fertilizer, Ltd. Factory, and only 50 percent of the respondents reported the same symptoms in Tolaram Nagar about two kilometers from the Rashtriya Chemicals and Fertilizer, Ltd. factory.

Also interesting to note is that the study tracked significant decreases in SO_x from 1978 to 1990; however, NO_x and Suspended Particulate Matter (SPM) increased (Larssen, 1997). So as the NO_x and SPM increased throughout the years and the closer a population was to the fertilizer factories, the reported respiratory symptoms increased (Larssen, 1997). In terms of the Aqua Fria riverbed sources and the EPRI study, anecdotally one would expect as the number of rock product sources increased in the mining pit of interest, so would PM_{10}, NO_x, and Ozone, which would be expected to negatively impact the health of the nearby residents based on the above research results.

<u>Regulatory Research Regarding Stationary Sources and Collocation</u>

As previously discussed above, numerous Hot Mix Asphalt Plants, Concrete Batch Plants, and Crushing/Screening Plants have been “collocated” in aggregate mining pits in Arizona and are potentially circumventing being categorized as a major stationary source pursuant to 42 USC § 7401 (aka: Clean Air Act). Title V of the Clean Air Act (CAA) defines a major source as one that emits 100 tons per yer (tpy) of a criteria pollutant and the NNSP/PSD definition is 100 tons per year for “categorical sources” or 250 tpy for non-categorical sources (United States, 1990). It is important to note that all the facilities used in this research are considered non-categorical sources. Once the emissions level and categorical/non-categorical determination is made, the source must then be analyzed to determine whether or not the facility fits the definition of stationary source. The CAA and Arizona Administrative Code (ACC), Title 18, Chapter 2, Section 101.113 defines a stationary source as, “any building, structure, facility or installation subject to regulation pursuant to Arizona Revised Statutes, Title 49, Section 426(A) which emits or may emit any air pollutant. “Building,” “structure,” “facility,” or “installation” means all of the pollutant-emitting activities which belong to the same industrial grouping, are located on one or more contiguous or adjacent properties, and are under the control of the same person or persons under common control. Pollutant-emitting activities shall be considered as part of the same industrial grouping if they belong to the same “Major Group” as described in the “Standard Industrial Classification Manual, 1987.”

Facilities in the mining pit of interest associated with this study often are not categorized in the same Standard Industrial Classification (SIC); however, the collocated facilities often fit the definition of a support facility designation and therefore, meet the SIC criteria as indicated in the August 7, 1980 preamble to the PSD regulations (45 FR 52695). The USEPA’s criteria for a “support facility” is as follows: “[e]ach source is to be classified according to its primary activity, which is determined by its principal product or group of products produced or distributed, or services rendered. Thus, one source classification encompasses both primary and support facilities, even when the latter includes units with a different two-digit SIC code (emphasis added). Support facilities are typically those which convey, store, or otherwise assist in the production of the principal product. Where a single unit is used to support two otherwise distinct sets of activities, the unit is to be included within the source which relies most heavily on its support."

The application of law as it applies to categorizing multiple sources as a stationary source is complicated, mainly due to the difficulty of proving common ownership or control. On face value the concept appears intuitive; however, the ability to find direct evidence to correlate the common control/ownership element is problematic. To prove common ownership or control, a regulatory body must compel the facilities to provide them with invoices, bids, lease agreements, corporate directives, etc. in order to prove common ownership or control. A regulatory entity can mandate that information either by issuing an administrative request for information letter or in court through the civil procedure of discovery, but discovery can be resource intensive, expensive and requires an active lawsuit. The information obtained by either request for information is protected from public review as long as the information has been deemed business confidential. The regulatory entity will handle the information as business confidential, if the information provided contains confidential information, such as, private contracts, trade secrets, process information, retail/wholesale information, etc.

Collocation In Other States

Collocation is a nation-wide problem and some states have attempted to pre-empt the illegal collocation by offering permit determinations or applicability determination guidance documents. Both Texas and Oklahoma have programs available to assist facilities in making a collocation determination. Oklahoma has a pre-permitting program for facilities, in which the facility can have a collocation permit determination conducted (ODEQ, 2005). The cost for Oklahoma's determination is $250 (ODEQ, 2005). Texas provides both the regulators and the public with a document entitled, "Definition of Site", which as it indicates on the title page of the document is regulatory guidance for defining stationary source (TCE, 2010).

Idaho has taken a different approach in addressing collocation. Idaho's General Permit for Concrete Batch Plants, Section 15 (Collocation) states that no other rock product facilities may collocate with the permitted plant and that the permitted plant may not locate within 305 meters of a hot mix asphalt plant or another concrete batch plant (IDEQ, 2011). The permit language clearly indicates that collocation is prohibited and leaves the determination up to defining stationary source to the permittee.

Summary

In summary, PM_{10}, NO_x, SO_x, and Ozone have been found to cause serious health issues in populations exposed to those pollutants. Moreover, ambient air quality studies directly indicate or show statistical trends that the closer a population is to collocation or concentrated sources of air pollution, the higher instances of respiratory illness or cancer cases are observed.

Federal and State regulations that apply to air quality permitting clearly delineate the types of sources that require a permit and the types of permits required (e.g. Title V, minor source, etc); however, regulatory agencies and the public particularly are growing more concerned that the General Permits for Hot Mix Asphalt, Concrete, and Crushing/Screening are being potentially used by collocation sources to circumvent applicable regulatory definitions that would ultimately require those sources to obtain individual permits and install more stringent pollution controls (Dempsey, 2011).

In the next several chapters, emissions calculations and data obtained by ADEQ will be analyzed to determine the collective emissions from a mining pit located in Sun City, Arizona. The mining pit has been and is currently used by several rock products facilities; however, none of the permitted entities have been linked to each other's operations (i.e., no evidence of common control). The result is that the nearby community maybe experiencing high levels of air pollution without the facilities being required to control their emissions collectively as they would if the collocated sources were defined under regulation as a "major source."

Chapter 3

METHODOLOGY

This study involved the collection of emissions data from seven rock products facilities located in the Aqua Fria River bed located near Sun City, Arizona. The study began with a literature review identifying academic and regulatory literature addressing the health effects of collocation, collocation, and concentrated emission sources. The 2008 Annual Emissions Inventories (AEI) were obtained from ADEQ and the Maricopa County Air Quality Department to determine the aggregated emissions from the seven facilities used in this study. ADEQ performed a comprehensive survey of permitted facilities in the study area in 2008. In researching for more recent data, no other surveys were found of the study area regarding air quality permitted facilities; therefore, the 2008 data set is the only confirmed emissions data for the study area.

The AEIs used in this study were required to be submitted in 2008 for emissions that were generated in 2007. Additionally, due to the downturn in economic development in the Phoenix Metropolitan Area, i.e., residential, commercial and road construction, the 2007 data would not reflect the highest output of emissions that would have occurred in previous years when the above industries would have been at a significantly higher production levels prior to the 2008 economic recession.

The emissions data were obtained from either the Arizona Department of Quality (ADEQ) or the Maricopa County Air Quality Department (MCAQD). The ADEQ data was submitted to the agency by the facility either by hard-copy or by using emissions reporting software that is used to upload emissions data to the USEPA's National Emission Inventory (NEI). The software calculates the specific emissions for each industrial process at the facility using the appropriate emission data (e.g. material throughputs, hours of operation, individual source test derived emission rates, AP42 emission rates, or manufacture derived emission rates). For the sources permitted by the Maricopa County Air Quality Department, an Excel spreadsheets was obtained from the agency, which identified each emissions point and the emissions output. The emissions data obtained reflect the official emissions inventory data submitted by the facilities used in this study. The data was reviewed by the appropriate regulatory agency for quality assurance, which includes the review of emission factors, material throughputs, fuel type, and fuel usage from all applicable emission sources.

In order to illustrate the pollution of collocated facilities as they affect the surrounding air quality, seven facilities all located in a contiguous mining site were selected and their respective AEI's were aggregated to determine the actual output of emissions from the study area.

Data Collection

The 2008 AEIs were obtained from ADEQ and the MCAQCD, which included the emission totals for all the pollutants emitted during the 2007 calendar year. The scope of this study focused on the criteria pollutants emitted from the facilities, specifically $PM_{10,}$ NO_x, SO_x, and VOCs. Of particular concern is PM_{10} due to Maricopa County's designation by the USEPA as a serious non-attainment area for PM_{10}. The emissions data obtained from ADEQ and the MCAQD is public information; however, the facilities have been labeled “Facility A, B, C, D, E, F and G.” The names of the actual facilities have been redacted; however, the permit numbers and place identification numbers have not been redacted. The 2008 emissions summary can be found in Chapter 4.

<u>Research Method</u>

The AEI calculations are based on calculations that take into account emission variables such as, material throughput, emission factors, hours of operation, and pollution control efficiency (i.e. percentage of pollution reduction of the control device). The emission variables used to calculate the emissions totals can be derived from emission unit specific sources test (aka: performance tests), USEPA AP-42, or manufacture supplied emission rates. The emission calculation output can change depending on the pollutant, horsepower (when applicable), type of pollution control device employed, hours of operation, fuels used (e.g. diesel, gasoline, used oil, etc.), and other emission unit specific factors.

Each emissions point is evaluated to develop the facility’s total emissions prior to the issuance or coverage under an air quality permit. Once all the individual emission points or sources are identified at a facility, then total emissions are calculated to determine the facility’s applicable permitting requirements, e.g., pollution controls, work practice limitations, etc. In this study, the AEI were used over the Potential-to-Emit in order to make an actual or real-world assessment of the true emission outputs.

Data Analysis

The emission totals from the seven selected facilities are aggregated and evaluated to determine the actual impact to the surrounding air quality. The analysis treated the mining site as a single facility as the emissions from the geographic area selected affect the surrounding population as a single emissions source.

Summary

This chapter summarized the data collection and research methodology used in this study. This chapter also provided an example of the how the emissions data was calculated and will be analyzed for the determining the affects of collocated sources of air pollution on the air quality within the Aqua Fria River bed adjacent to Sun City, Arizona.

Chapter 4

RESULTS

The major purpose of this study was to determine if the regulatory threshold for “major source” would be triggered if all the facilities emissions were summed as a single source. The facilities used in this study are located in a single aggregate mining pit located along the Aqua Fria river bed and are operating on a “contiguous” property and either have the same SIC or are “support facilities”. However, it is uncertain whether or not the common control element of the stationary source definition can be satisfied since that information cannot be obtained by any legal mechanism available. The information to prove the common control element includes, bids, contracts, invoices, etc. and is deemed business confidential.

However, for the purposes of determining if the mining pit in general could be a major source of criteria pollutants, the emissions from all the facility’s listed in Chapter 1, namely, Facility A through G have been summed together to make a major source assessment. It is important to note, that Facility C did not receive an air quality permit from the Maricopa County until February 2008 and therefore was not required to submit an AEI to the agency. As such, the calculation is an under estimate of emissions from the Agua Fria mining pit used in this study.

Data Findings

Each facility’s function and basic description has been identified in Chapter 1 and as previously discussed the emission totals were based on actual

Annual Emission Inventory's submitted and review by either ADEQ or MCAQDC for accuracy. The emissions summary is found in the following table.

Table 1 - Summary of Emissions in Tons per Year of Selected Pollutants for Calendar Year 2007

Facility Name	NO_x	SO_2	PM_{10}	VOC	CO
Facility A (Concrete Batch)	0.01	0.006	0.012	0.02	0.4
Facility B (Concrete Batch)	ND	ND	3.85	ND	ND
Facility C (Crushing & Screening)	NO DATA AVAILABLE*				
Facility D (Concrete Batch)	0.32	0.00025	0.77	0.0012	0.0043
Facility E (Crushing & Screening)	19.5	5.5	1.43	0.66	4.45
Facility F (Hot Mix Asphalt)	1.97	0.48	0.32	0.16	0.69
Facility G (Crushing & Screening)	30.26	9.18	2.85	0.89	6.93
Total Emissions (Tons/Year)	**52.06**	**15.16625**	**9.232**	**1.7312**	**12.4743**

ND = No Data Available on MCAQD Emission Inventory

*Facility C was not issued a permit until 2/22/08; therefore, no AEI was requested for 2007

The above results clearly indicate that if the facilities emissions are taken as a total source that they do not meet the definition of "major source" as the total emissions do not exceed a 100 tons per year of a single criteria air pollutant or 250 tons per year of a combination of criteria air pollutants according to the State of Arizona's major source definition. Additionally, the results above also do not exceed Maricopa County's, Rule 241, Section 210, PM_{10} non-attainment major source emissions threshold of 70 tons per year. It should also be noted that even if the highest emissions from each criteria pollutant category are used to substitute the unavailable data for Facility C, that the summed total would still not meet the "major source definition" based on the State of Arizona or Maricopa County's definition.

These results indicate that the emissions from the Aqua Fria pit would not require a Class I or major source permit by the State of Arizona or the federal government. However, the above emissions would trigger Maricopa County BACT for NO_x pursuant to Maricopa County Rule 241, Section 300, which states that,

> "Any new stationary source or modified source, which emits more than 150 lbs/day or 25 tons/year of volatile organic compounds, nitrogen oxides, sulfur dioxide, or particulate matter; more than 85 lbs/day or 15 tons/year of PM10; or more than 550 lbs/day or 100 tons/year of carbon monoxide."

Therefore, the collocated facilities exceed the 25 tons per year BACT trigger for NO_x with facility G triggering BACT for NO_x alone. Assuming that the collocated facilities operate five days a week during a calendar year, equaling 261 days of operation, then the total NO_x would also trigger daily BACT limits, i.e. 51 tpy x 2,000 lbs/ton = 102,000 lbs/261 days = 390 lbs/day.

In regards to Facility G, assuming that the facility operated five days a week during a calendar year, equaling 261 days of operation at 30 tpy of NO_x, then the daily NO_x emissions would be 229 lbs/day and Facility G would trigger the daily NO_x BACT limit.

In light of the BACT issues discussed above, NO_x emissions from the collocated sources may be negatively affecting the health of nearby residents. The emissions presented above also assume that the facilities in question are in compliance regarding their air pollution controls. Given the above scenario and if the collocated facilities are operating out of compliance with any pollution control requirements, then the increased air pollution could be significantly impacting the air quality of nearby populations.

PM_{10} Emissions

The Aqua Fria aggregate mining pit that was selected for this study was used because it represented a high concentration of sources and that it contained a cross-section of the rock product facilities, i.e., Concrete Batch Plant, Hot Mix Asphalt, and Crushing/Screening. Table 2 below is an itemization of PM_{10} emission by industry type.

Table 2 – PM_{10} Emissions In Tons Per Year

Facility Type	PM10
Facility A (Concrete Batch Plant)	0.012
Facility B (Concrete Batch Plant)	3.85
Facility C (Crushing/Screening Plant)	No Data
Facility D (Concrete Batch Plant)	0.77
Facility E (Crushing/Screening Plant)	1.43
Facility F (Hot Mix Asphalt Plant)	0.32
Facility G (Crushing/Screening Plant)	2.85
Total Emissions (Tons/Year)	**9.232**

The itemization of emissions by industry indicates the average emissions from Concrete Batch Plant activities in the Aqua Fria pit equates to 1.54 tons/year, but represents 50 percent of the PM_{10} emissions. Crushing and Screening activities average emissions equates to 2.14 tons/year and represents 46.3 percent of the total PM_{10} emissions, but would be expected to be higher due to the absent emissions data for Facility C.

In regards to this aggregate mining pit, Concrete Batch Plant activities tend to be the more significant contributor of PM_{10}. Hot Mix Asphalt production contributes minimally to the overall PM_{10} emissions, only emitting 3.47 percent of the total PM_{10} emissions from the mining site. The one missing element of this emissions calculation is the excess or uncontrolled emissions. The above calculation is only based on the reported allowable emissions; however, the above calculation does not account for excess emissions.

The above emissions statistics could be important from an air quality planning perspective as the Aqua Fria mining site used in this study is located in the Maricopa County PM_{10} non-attainment area.

NO_X and VOC

The NO_x and VOC emissions from the Aqua Fria mining pit are surprising low given the number of facilities in operation. The explanation of why the NO_x emissions appear lower than expected is that several of the Maricopa County permitted facilities are on grid power. The facilities that are portable throughout the state of Arizona require an ADEQ permit. Those state regulated facilities often move to parts of the state where electricity is unavailable; therefore, in order to power the equipment required to operate, portable electric generators are employed.

In reviewing the emissions data for NO_x and VOC, one can determine that the facilities with the highest NO_x and VOC emissions are in fact ADEQ permitted facilities and are directly attributable to the generators emissions based on the emission descriptions presented in Chapter 1. Table 3 below provides an itemization of emissions by industry

Table 3 – NOx and VOC Emissions in Tons per Year

Facility Name	NO_x	VOC	Permitting Agency
Facility A (Concrete Batch)	0.01	0.02	ADEQ
Facility B (Concrete Batch)	No Data	No Data	Maricopa
Facility C (Crushing/Screening)	No Data	No Data	Maricopa
Facility D (Concrete Batch)	0.032	0.0012	Maricopa
Facility E (Crushing/Screening)	19.5	0.66	ADEQ
Facility F (Hot Mix Asphalt)	1.97	0.16	ADEQ
Facility G (Crushing/Screening)	30.26	0.89	ADEQ
Total Emissions (Tons/Year)	**52.06**	**1.7312**	

The above table indicates that the ADEQ permitted portable facilities have significantly higher NO_x and VOC emissions. The statewide portable facilities are permitted by ADEQ pursuant to A.R.S 49-402, while the facilities that operate exclusively in Maricopa County are permitted by MCAQD. Again, the explanation for the ADEQ permitted facilities having higher NO_x and VOC emissions is due to the portable nature of those facilities, which require electric generators to provide power for on-site equipment in rural areas of the state.

As previously mentioned, the Maricopa County permitted facilities are operating on grid power, as they are likely to be stationary sources or only portable in Maricopa County, suffice to say, an urban county. Those sources will connect to grid power to decrease NO_x and VOC emissions. By decreasing NO_x and VOC emissions, a facility can increase their hours of operation without triggering major source or Maricopa County Best Available Control Technology (BACT) requirements for NO_x or VOCs and in turn increase their operating hours to produce and sell more product. Table 3 also indicates that even with several facilities that appear to be on generator power, the total combined NO_x or VOC emissions do not exceed 100 tons/year for a single pollutant, but do exceed BACT as discussed above.

As with the previous table, specific industry types account for significantly higher emissions than others located in the Aqua Fria pit. However, in regards to NO_x and VOC emissions, one finds that the Crushing/Screening facilities are by far and away the majority emitters. The Crushing and Screening facilities are responsible for 96 percent of the NO_x emissions and 90 percent of VOC emissions, while a single Hot Mix Asphalt plant is responsible for nine percent of NO_x emissions and nine percent of VOC emissions.

SO_x/SO_2 Emissions

The emissions for SO_x for the rock products are directly related to the fuels in use to generate power and the use of asphaltic oil associated with the production of Asphalt (See Chapter 1 for emissions profile for each facility). The main source of SO_x in the Aqua Fria pit is again associated with the facilities using portable generators to provide electric power to operate the facility. Diesel powered generators appear to be used as gasoline typically does not contain nearly as much sulfur as diesel (See Chapter 1). Table 4 itemizes the SO_x emissions by facility and industry.

Table 4 – SO_x Emissions by Industry and Agency in Tons per Year

Facility Name	SO_2	Permitting Agency
Facility A (Concrete Batch)	0.006	ADEQ
Facility B (Concrete Batch)	No Data	Maricopa
Facility C (Crushing/Screening)	No Data	Maricopa
Facility D (Concrete Batch)	0.00025	Maricopa

Facility E (Crushing/Screening)	5.5	ADEQ
Facility F (Hot Mix Asphalt)	0.48	ADEQ
Facility G (Crushing/Screening)	9.18	ADEQ
Total Emissions (Tons/Year)	**15.17**	

As stated above, the SO_x emissions are associated with ADEQ permitted portable facilities, which are powered by fossil-fuel burning generators. Similar to what was observed with NO_x emissions, Crushing and Screening in the Aqua Fria pit accounts for the significant majority of SO_x emissions, representing 93 percent of SO_x emissions. The Hot Mix Asphalt plant accounted for seven percent of the SO_x emissions. Those emissions are due to both generator usage and the off-gasing of asphaltic oil, which is typically heated close to the smoke point in order to make compacting the asphalt easier during application for roads or parking lots.

CO Emissions

The CO emissions from the facilities operating in the Aqua Fria pit are a direct result of fossil-fuel combustion. As with NO_x and SO_x, CO is a by-product of fossil fuel usage in the Aqua Fria pit due to emissions associated with portable electrical generators. Table 5 itemizes the CO emissions by facility and industry.

Table 5 – CO Emissions

Facility Name	**CO**	**Permitting Agency**
Facility A (Concrete Batch)	0.4	ADEQ
Facility B (Concrete Batch)	No Data	Maricopa
Facility C (Crushing/Screening)	No Data	Maricopa
Facility D (Concrete Batch)	0.0043	Maricopa
Facility E (Crushing/Screening)	4.45	ADEQ
Facility F (Hot Mix Asphalt)	0.69	ADEQ
Facility G (Crushing/Screening)	6.93	ADEQ
Total Emissions (Tons/Year)	**12.47**	

Similar to NO_x and SO_x, CO is emitted mainly by the Crushing and Screening facilities operating in the aggregate pit. Crushing and Screening accounts for 74 percent of the total CO emissions in the pit with the Hot Mix Asphalt plant emitting 24 percent. The Hot Mix Asphalt is responsible for a significant portion of CO emissions, especially compared to its contribution to NO_x/VOCs and SO_x. Unlike the Crushing and Screening facilities, which produce CO by the use of electric generators, the CO emissions from the Hot Mix Asphalt plant is a combination of electric generators and off-gassing from the asphaltic oil (See Chapter 1 for facility specific emissions profile).

Chapter 5

CONCLUSIONS AND RECOMMENDATIONS

The literature review in Chapter 2 provided information regarding potential health impacts associated with PM_{10}, NO_x, and VOC. The studies selected were used as they are the main pollutants associated with the rock products industry. Additionally, the literature review presented environmental health information concerning the potential health effects of populations located adjacent to or near collocated sources of air pollution, along with a regulatory analysis of major source.

The ultimate purpose of this study was to evaluate whether or not all the sources of air pollution in a single aggregate mining pit would emit major source levels of criteria pollutants. More specifically, if those emissions were aggregated as a single source, would those emissions be greater than 100 tons per year and constitute a major source pursuant to Title V of the Clean Air Act and if the emissions would be greater than 250 tons per year for a non-categorical source pursuant to Nonattainment New Source Review (NNSR) or the Prevention of Significant Deterioration (PSD) programs. Also, if the emissions were aggregated, would the facilities collectively trigger Maricopa County BACT. The area selected is a well-documented area along the Aqua Fria riverbed and was surveyed by ADEQ as to the sources located in and along the riverbed.

The conclusions of this study are:

1. If the seven sources (only six had emissions data) are taken as a single source of emissions, the total emissions do not calculate to

greater than 100 tons per year. Therefore, the sources in question do not constitute a major source as defined under Title V of the Clean Air Act or NSR/PSD.

2. The sources collectively trigger the 25 tons per year and the daily 150 pounds per day BACT thresholds for NO_x with Facility G triggering both thresholds alone.

3. An analysis of each criteria pollutant from the above sources indicates that the majority of emissions from all the facilities reviewed in this study are from fossil fuel combustions sources, namely, portable electric generators (See Chapter 1 for facility specific emissions profile).

The collocation sources used in the study do not meet the major source emissions criteria, but do trigger the Maricopa County BACT thresholds. Furthermore, other areas with higher concentrations of collocated sources could have significantly increased emissions due to different configurations and size of equipment used in the operation. This study represents only one of numerous aggregate mining pits or areas of operation with collocated sources of air pollution in Arizona. Other areas may very well be comprised of larger facilities with significantly higher emission totals. Additionally, in more rural areas of Maricopa County or other parts of Arizona, electrical power is derived solely from portable electrical generators, which is significantly contributing to NO_x emissions.

In the situations where collocated facilities are relying on generator power, one would expect higher NO_x, CO, and VOC emissions, as those are the pollutants associated with internal combustions engines. Therefore, there is a high likelihood that other rural, larger or more heavily industrialized aggregate mining pits could be major sources and could have significant air quality and health impacts.

The NO_x and VOC percent producer by industry data has potential planning implications in terms of determining which type of industry produces the highest emissions of a certain pollutant. While fuel types and power sources influence emission outputs, the gaseous emissions from the Aqua Fria pit appear to be mainly attributed to the Crushing and Screening activities as will be further discussed below

Recommendations for Further Study

While many planning and zoning organizations promote the collocation of industrial sources, those areas must account for the situation described in this study, namely, that collocated sources could be circumventing regulatory emission thresholds that would ultimately require increased pollution control. Based on the potential for negative air quality impacts from collocated rock product facilities, it is recommended that:

1. Further study be conducted on multiple collocated rock product sources in Maricopa County and throughout Arizona to determine what affect those sources have on the ambient air quality by conducting additional emissions analysis and cumulative modeling. Cumulative modeling would

allow planners and regulators to determine what the actual air quality impacts are from collocated sources.

2. Further study be conducted on the power sources used and the potential to provide “grid power” to sources currently operating on fossil-fuel generator electrical power. Switching from generator power to “grid power” would eliminate localized NOx, CO, SO_x, and VOC emissions or using cleaner fuel sources could also contribute to lower emission levels

3. Further epidemiological studies be conducted on populations located near collocated sources of rock product facilities. Those studies would be useful in assessing the actual health impacts to populations located near collocated sources.

4. Petition the State of Arizona to develop regulations for emissions associated with collocation. Those rules could either set emission limits and/or pollution control requirements for aggregate mining sites as a whole and require all the facilities located in single mining pit to permit themselves as a single facility.

5. Petition the Arizona Department of Environmental Quality to develop a permit specific to mining sites or pits (i.e. permit the mining site or pit), particularly in urban counties like Maricopa County. The permit could require more stringent pollution control or work practices to better protect the public from air pollution from collocated sources.

REFERENCES

Amann, Markus et al. (2008). The health effects ozone from long range transboundary air pollution. Retrieved on November 7, 2011, from, http://www.euro.who.int/__data/assets/pdf_file/0005/78647/E91843.pdf

Arizona Administrative Code, Title 18, Chapter 2 (Air Pollution Control), (2009).

Arizona Department of Environmental Quality. (2008). Portable air sources & facililtites (sic) in the Aqua Fria river site. Phoenix, AZ.

Arizona Revised States, Title 49, Chapter 3 (Air Quality), Chapter 3 (2010).

Blankenship, K. (1997). Report outlines harmful impacts of NOx emissions. Retrieved October 24, 2010, from http://www.bayjournal.com/article.cfm?article=2178

Bryner, G. C. (1993). Blue skies, green politics. Washington, D.C.: CO Press.

Dempsey, Jeff (2011). Study: Aqua Fria does not require more air monitoring. Retrieved on August 19, 2011, from http://www.eastvalleytribune.com/local/the_valley/westvalley/article_5cdaea43-8602-5321-891e-9e46a61df6ad.html

Ebbing, Darrell D. (1993). General Chemistry. 4th ed. Boston, MA: Houghton Mifflin.

Ebner, Paul (2007). CAFOs and Public Heath: Pathogens and Manure. Retrieved October 24 2010, from http://www.extension.purdue.edu/extmedia/ID/cafo/ID-356.pdf

Gilmour, Peter S., et al. (1996). Adverse health effects of PM_{10} particles. *Occupational and Environmental Medicine*, *53*, 817-822.

Hathaway GJ, Proctor NH, Hughes JP, and Fischman ML. (1991). Proctor and Hughes' chemical hazards of the workplace. *3rd ed*. New York, NY: Van Nostrand Reinhold.

Helfand, William H., et al. (2001). Donora, Pennsylvania: An environmental disaster of the 20th century. *American Journal of Public Health*, *91*(4), 553.

Idaho Department of Environmental Quality. (2011). General permit to construct a concrete batch plant. Retrieved on August 23, 2011, from, http://www.deq.idaho.gov/permitting/air-quality-permitting/permit-to-construct/concrete-batch-plants.aspx

Jerrett, Michael, Ph.D., et al. (2009). Long-term ozone exposure and mortality. *The New England Journal of Medicine, 360* (1085-1095), October 24, 2010.

Larssen, S., et al. (1997). Urban air quality management strategy in asia: Greater mumbai report. (Technical Report No. 381). Washington, D.C.: World Bank.

Maricopa County Air Quality Department. (2010). Requirements, Procedures, and Guidance in Selecting BACT and RACT. Retrieved on November 11, 2011, from http://www.maricopa.gov/aq/divisions/permit_engineering/docs/pdf/BACT%20Guidance.pdf

Michelozzi, P, Fusco, D, Forastiere, F, Ancona, C, Dell'Orco, V, Perucci, C A. (1998). Small area study of mortality among people living near multiple sources of air pollution. *Occupational and Environmental Medicine, 55(9), 611-615.*

Oklahoma Department of Environmental Quality. (2005). Air: permitting of collocated facilities. Oklahoma City, Ok: Publications Clearinghouse of the Oklahoma Department of Libraries.

Sillman, S., Ph.D. (2010). Tropospheric ozone, smog, and ozone-NO_x-VOC sensitivity. Retrieved October 24, 2010, from http://www-personal.umich.edu/~sillman/

Texas Commission on Environmental Quality. (2010). Definition of site guidance document. Retrieved on August 23, 2011, from, http://www.tceq.state.tx.us/assets/public/permitting/air/Guidance/.../site.doc

United States, 42 USC § 7401 (Clean Air Act), I-V (1990).

United States Environmental Protection Agency. (1997). *Nitrogen oxides: Impacts on public health and the environment.*

United States Environmental Protection Agency. (2010). Particulate matter: Health and environment. Retrieved September 30, 2010, from http://www.epa.gov/PM/health.html

Willett, Jason Christopher. (2010). The Nation's Top Producers. Retrieved November 8, 2011, from http://www.aggman.com/special-section

BIOGRAPHICAL SKETCH

Timothy S. Franquist, Jr. works for the Arizona Department of Environmental Quality as Manager of the Air Quality Compliance Section. He graduated from the University of Maryland, College Park in 2000 with a Bachelor of Arts degree in Environmental Science and Policy concentrating in Environmental Sociology. Mr. Franquist began his career as Research Assistant working for the Environmental Defense Fund in Washington D.C., where he researched mercury and poly-vinyl chloride usage in the automotive supply chains. He later moved to the private sector and worked as an environmental scientist conducting environmental investigations, petroleum remediation, soil/gas surveys, wetland delineation, and underground storage tank removals. He also worked for the Baltimore County Soil Conservation District as a Technical Reviewer for sediment control plans. At the Arizona Department Environmental Quality, he has worked as an Environmental Program Specialist in the Water Quality Division, Total Maximum Daily Load Unit and as a Compliance Inspector in the Waste Programs Division, Underground Storage Tank Unit.